Bird assemblage in a dune-mangrove mosaic, Cairns, Queensland

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ABSTRACT

Australia has a large suite of mangrove dependent bird species. Apart from detailed work in the Northern Territory, there has been little additional survey of bird pattern in this vegetation type. The abundance and habitat preference of birds were surveyed in six vegetation types on Trinity Inlet, Cairns. Birds were counted on four occasions from 1998-1999, and forty-seven bird species, representing nine foraging guilds, were recorded. Vegetation type was a strong discriminator of bird composition. I recorded a number of mangrove-obligate species (e.g. Collared Kingfisher, Mangrove Robin, Mangrove Gerygone) more abundantly, or restricted to mangrove vegetation, and a further suite of species that were mangrove-facultative (e.g. Shining Flycatcher, Rufous Fantail, Helmeted Friarbird, Spangled Drongo, Brown Honeyeater, Dusky Honeyeater). Many of the species recorded are more typically associated with rainforest, open woodlands and forests (e.g. Spectacled Monarch, Rose-crowned Fruit-dove, Variegated Fairy-wren, White-throated Honeyeater). There was some pattern in the guilds with granivores and frugivores being relatively more abundant in dune vegetation and foliage insectivore and nectarivore guilds being more so in mangroves. The pattern of bird assemblage reported is similar to those reported in the Northern Territory, and is considered to be determined by mangrove specialisation, habitat structure, available resources and neighbouring habitats.

Key words: birds, guilds, mangroves, dunes, habitat, Australia.

Introduction

Mangrove communities are often the most extensive community in coastal wetland complexes, and species-richness of mangroves in northern Australia is considered to be the highest in the world (Davie 1987; Hutchings and Saenger 1987; Lovelock 1993). Despite their extent and diversity in Australia and the significant role they play in marine and estuarine productivity, terrestrial ecologists have generally shunned these systems for study (Woinarski 2004). Two recent papers cite the neglect of mangroves due to unpleasant working conditions (biting insects, tides, crocodiles) (Winter 2004; Woinarski 2004). The general values of mangrove for fauna has received some limited survey and review (Macnae 1966; Hutchings and Recher 1982; Hutchings and Saenger 1987; Kutt 1997), all concluding that this vegetation provides significant primary and seasonal resources for many vertebrate species, and is often an important habitat refuge in coastal areas where there has been substantial urban development.

Complementary to the species richness in mangrove communities, Australia has by far the greatest number of mangrove-obligate bird species in the world. Fourteen species are virtually confined to mangrove communities, and a further twelve utilise this vegetation as primary habitat in part of their range (Ford 1982; Schodde *et al.* 1982; Noske 1996). In Malaysian mangroves, where the species richness is comparable to Australia, four birds are restricted to mangroves while in the floristically less diverse mangroves of South America and Africa there is only one true obligate bird species (Haverschmidt 1965; Altenberg and Spanje 1989; Noske 1995). Specialisation of bird species to mangrove habitat includes a preference for warm, mesic, closed canopy habitats and the dependence on particular kinds of food such as inter-tidal invertebrates, mangrove blossoms and terrestrial invertebrates (Schodde *et al.* 1982). However, mangrove-obligate birds do not use these resources exclusively. In Australia, an additional 60 bird species have been recorded using mangroves regularly or seasonally (Ford 1982; Schodde *et al.* 1982; Hutchings and Saenger 1987; Noske 1996). Apart from the food, it has been suggested that these facultative mangrove bird species use mangroves for breeding, and habitat as refuge during migration, winter seasons and drought (Schodde *et al.* 1982; Hutchings and Saenger 1987).

The distribution, endemism and taxonomy of Australian mangrove birds have received some attention (Ford 1982, 1983; Schodde *et al.* 1982; Johnstone 1990). This has included observations of feeding and diet, and habitat partitioning of mangrove endemic birds (Schodde *et al.* 1982; Johnstone 1990). Many species are shown to exhibit association with particular mangrove zones (Noske 1996; Noske 2001).

The Cairns International Airport (CIA) coastal wetlands support a complex of dune and mangrove vegetation types which are important habitat for local fauna species (Kutt 1997). In the study reported here, I surveyed the avifauna of this vegetation mosaic over a number of seasons, and investigated two complementary questions: do the bird species recorded there associate with particular mangrove and dune vegetation types; and are these patterns similar to those reported elsewhere in Australia.

Methods

Study location

The estuarine wetlands of the Cairns International Airport (CIA) study area (19° 55'S, 145° 45'E), lies 5 km to the north of Cairns, (Fig. 1). It covers an area of 366 ha and is situated within the broader 4500 ha coastal complex of Trinity Inlet. This inlet environment represents a large system of marine, intertidal, wetland and terrestrial vegetation communities and habitats including mangroves, seagrass beds, claypans, mudflats, sand ridges and freshwater swamps. Trinity Inlet is unusual in that it is a tidally dominated inlet, not being flushed by a major river, though the Barron River exits directly into the Coral Sea on its northern boundary, which also constitutes the northern boundary of the CIA. This is an uncommon coastal habitat association in northern Queensland and has evolved from a combination of factors including the sheltered nature of Trinity Inlet, the sediment washed from the Barron River and the high annual rainfall of the region (>2000 mm). Approximately 80% of the remaining undisturbed dune-ridge communities of Trinity Inlet occur within in the CIA study area.

Study sites and sampling

Six vegetation types were identified for survey: fore-dune, dune, mixed mangrove community, *Ceriops* community, and a "small" and "large" *Rhizophora* community (Table 1). In each of the six vegetation types, three surveys sites were established. Each survey site was in a separate "polygon" of that vegetation type, to ensure there was no pseudo-replication. Surveys were conducted on four occasions: April 1997, May 1998, November 1998 and February 1999. Birds were sampled via ten-minute, one-hectare counts. All birds seen or heard within this area during this period were recorded. Three bird censuses were conducted at each site over a four-day period (a total of 30 minutes for the hectare), and no site was surveyed twice on any single day, nor consecutively. All counts were conducted within two hours of dawn. At the end of each sampling period (i.e. month) the three totals were pooled to give a total abundance score per site, for each month sample.

Analysis

The relative effect of vegetation type and time period (month) on bird abundance and species richness was examined via two-way repeated-measures ANOVA, using vegetation as a factor and time as the repeated measure (Table 2).

Using the site data pooled for all months sampled, the 18 sites were ordinated (with the data square-root transformed, and Bray-Curtis similarity matrix) using multi-dimensional scaling (Primer 6.1.6, 2006), and labelled with vegetation type (Fig. 2). Analysis of similarity (ANOSIM) was used to examine the strength of the vegetation classification in defining species composition (Clarke and Gorley 2001). Two resemblance levels were mapped; 50% and 60% similarity (Fig. 2).

The relative abundance of foraging guilds in each vegetation type was graphed to identify the variation in community guild structure. Birds were assigned to foraging guilds using the categories in Woinarski and Tidemann (1991). Variation in the abundance of bird species across vegetation type was examined using nonparametric (Kruskal-Wallis) one-way analysis of variance (Table 3). Only species recorded in more than one site were examined.

Table 1. Short description of the five coastal wetland vegetation types sampled in the Cairns International Airport study.

Community	Description
Fore-dune community	Located on shorelines, and consisting of exposed vegetation representing the primary stage of development of beach scrub habitat. Canopy species comprise of *Terminalia catappa*, *T. muelleri*, *Casuarina equisetifolia*, *Acacia oraria* and *Exocarpus latifolius* (all to 20 m) with a ground cover of *Panicum maximum**, *Bothriochloa bladhii* and *Jasminum aemulum*. Generally poorly developed structure due to tide and wind influence, and highly weed infested.
Dune community	Tall well-developed beach forest to 35m, representing historic shorelines. This community is dominated by emergent *Melaleuca leucadendra* and a diverse mid-storey of *Acacia crassicarpa*, *A. flavescens*, *Canarium australianum*, *Cupaniopsis anacardioides*, *Pleiogynium timorense*, *Pongamia pinnata* and *Terminalia muelleri*.
Mixed mangrove community	Mangrove forest associated with edges of dune habitat and smaller drainage lines, consisting of a mixture of *Ceriops* spp. and *Rhizophora* spp. growing to 10m.
Ceriops community	Mangrove community associated with the fringes of salt pans and woodland areas where there is some freshwater influence. Predominantly a mixture of all three *Ceriops* species, *C. tagal*, *C. decandra* and *C. australis*, all no more than 5-7 m.
Small *Rhizophora* community	Mangrove community near shorelines behind the foredune or *Avicenna* habitats and along smaller drainage lines. More exposed than the larger *Rhizophora* community, and predominantly Red Mangrove *Rhizophora stylosa* from 10-12 m, with occasional Wrinkle Pod Mangrove *Cynometra iripa* and Cedar Mangrove *Xylocarpus mekongensis*.
Large *Rhizophora* community	Mangrove community found in more sheltered zones (protected from on-shore winds and cyclones) directly behind *Avicenna marina* forests. Predominantly Tall-stilted Mangrove *Rhizophora apiculata* growing in monocultures to 25 m.

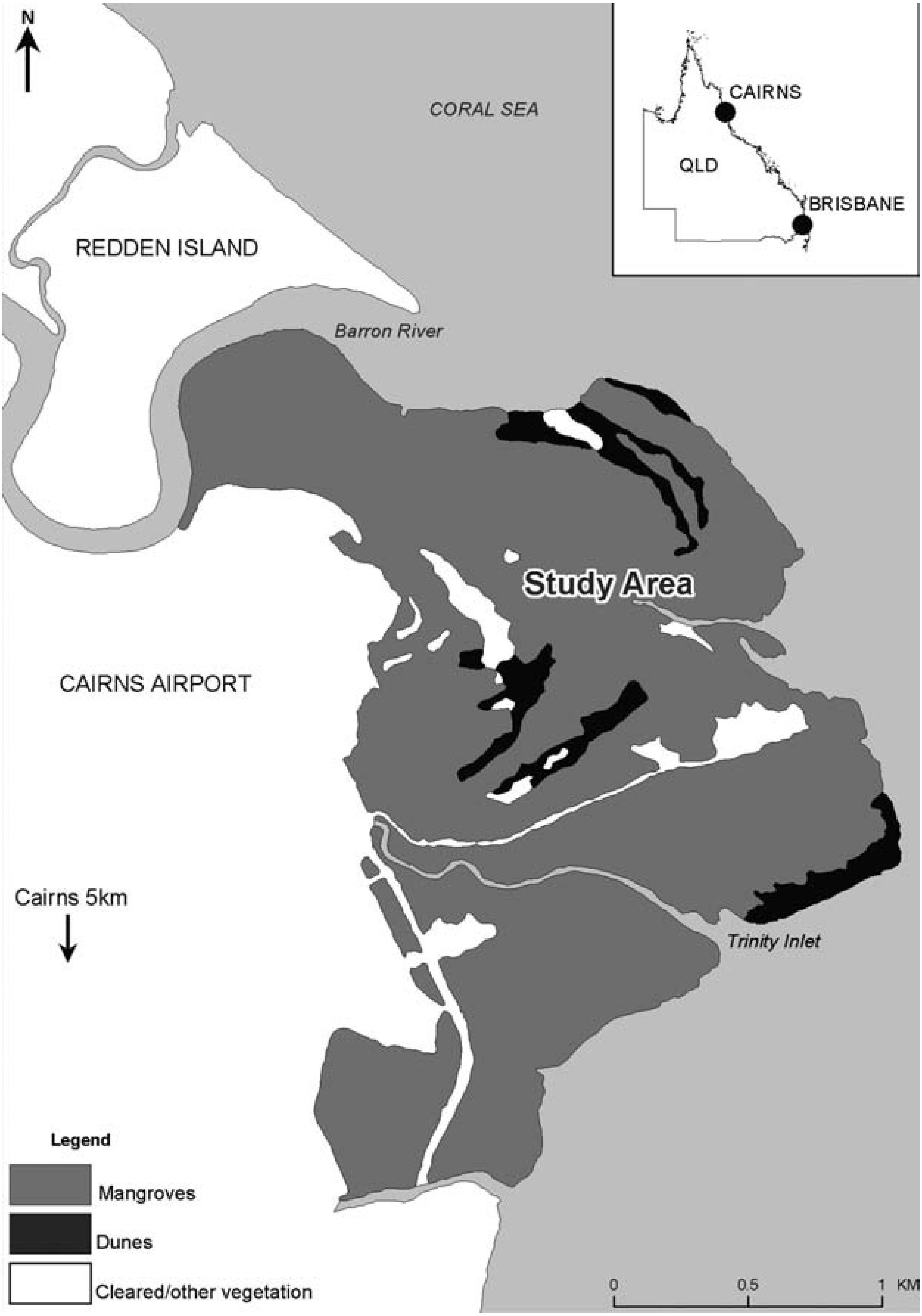

Figure 1. Location of Cairns International Airport study area.

Table 2. Two-way repeated measures ANOVA of bird abundance and richness for entire assemblages.

Variable	Factor	d.f.	F	p
Abundance	Vegetation	5	1.64	ns
	Month	3	1.16	ns
	Month*Vegetation	15	0.96	ns
Species richness	Vegetation	5	3.13	*
	Month	3	2.79	ns
	Month*Vegetation	15	2.29	*

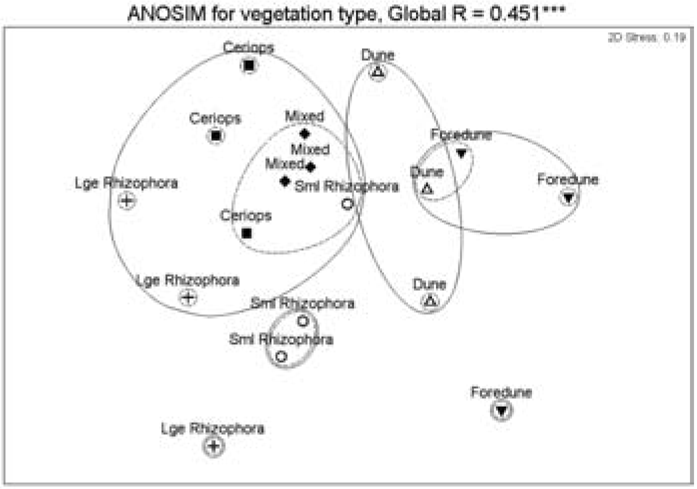

Figure 2. Multi-dimensional scaling in two dimensions of the sample sites, using square-root transformed pooled abundance data (stress=0.19). The solid line represents 50% similarity and the dashed line 60%.

Results

A total of 47 bird species, representing nine foraging guilds, was recorded during the bird survey. The most abundant species were Brown Honeyeater, Helmeted Friarbird, Rainbow Lorikeet, Mistletoebird, Yellow-spotted Honeyeater and Graceful Honeyeater. These were also the most frequently recorded. Aerial insectivores (8 species), nectarivores (6 species), foliage insectivores (6 species), and foliage insectivores/nectarivores (6 species) were the dominant bird guilds (Table 3).

Two-way repeated measures ANOVA of bird abundance and richness for entire assemblages identified that there was no significant effect of vegetation or month on abundance, but vegetation and the interaction of vegetation and month accounted for variation in species richness (Table 2). Total bird species richness was broadly similar across vegetation types (21-27 for species richness, Table 3). Site species richness was highest in mixed mangrove and dune sites, and lowest in the large *Rhizophora* and *Ceriops* vegetation. Abundance followed a similar pattern. Though not tabulated or analysed further, species richness was highest in April, predominantly in the mixed mangrove, *Ceriops* and dune vegetation.

Analysis of similarity indicated that vegetation type was a strong discriminator of bird composition (Global Rho = 0.451***) (Fig.1). Consequently the ordination revealed a reasonable degree of separation between the dune and mangrove vegetation types, and between some of the mangrove groups such the *Rhizophora* and the mixed/*Ceriops* types (MDS stress = 0.19).

Fifteen bird species varied significantly in abundance across the six vegetation types (Table 3). In the dune and foredune, the significantly abundant species were typically woodland or beach-scrub birds (Rainbow Bee-eater, Helmeted Friarbird, Orange-footed Scrubfowl, Varied Triller in foredune; Yellow-bellied Sunbird, Bar-shouldered Dove, Mistletoebird in dune), representing seven guild types (aerial insectivore, foliage insectivore/nectarivore, granivore, ground insectivore/omnivore, frugivore, nectarivore). In the mangrove vegetation types, the distribution of species significantly more abundant in each type was evenly spread (Mangrove Gerygone and Varied Honeyeater in small *Rhizophora*; Collared Kingfisher and Mangrove Robin in large *Rhizophora;* Shining Flycatcher, Little Bronze-cuckoo and Graceful Honeyeater in mixed mangroves; and Brown Honeyeater in *Ceriops*). The species in the mangrove vegetation were more prominently foliage insectivores and nectarivores (five out of eight) and species considered mangrove endemics (Mangrove Robin, Mangrove Gerygone, Mangrove Honeyeater, Collared Kingfisher).

The relative abundance of foraging guilds in each vegetation type (Fig. 3) identified some subtle variation. Granivores were more abundant in the foredune and dune vegetation, but largely absent from the mangrove vegetation. Similarly frugivores were more abundant in the dunes, though also present in the mangrove vegetation. Aerial insectivores and raptors were more abundant in the foredune and large *Rhizophora* vegetation, though aerial insectivores were relatively abundant in the large *Rhizophora,* mixed and *Ceriops.* Ground insectivores and omnivores were generally low across all vegetation. Finally the foliage insectivore and nectarivore groups were generally the most abundant birds, and more so in the mangrove vegetation types.

Discussion

The total of 47 species from the current survey compares favourably to other surveys of birds in mangrove vegetation mosaics (60 species, Ford 1982; 50 species, Noske 1996), though only six mangrove specialised/obligate species were shared by each study (Striated Heron, Mangrove Robin, Varied Honeyeater, Little Kingfisher, Collared Kingfisher, Mangrove Gerygone). Noske (1996) identified 11 mangrove specialised birds in his three-year study of Darwin mangroves, and in this study three of these mangrove specialists (Collared Kingfisher, Mangrove Robin, Mangrove Gerygone) were significantly more abundant in the mangrove vegetation. Ten further species recorded in the present study are considered mangrove-facultative (Little Bronze-cuckoo, Shining Flycatcher, Rainbow Bee-eater, White-bellied Cuckoo-shrike, Cicadabird, Rufous Fantail, Helmeted Friarbird, Spangled Drongo, Brown Honeyeater, Dusky Honeyeater; Ford 1982; Noske 1996). Two species considered mangrove-obligates in the other studies, were recorded in dune sites in the current survey (Collared Kingfisher, Mangrove

Table 3. Variation in bird species abundance across the six vegetation types. Only species recorded in more than one site were examined. The significance in variation in abundance tested via Kruskal-Wallis Test, (all seasonal samples pooled) five vegetation types. Probability levels are <0.1, *=p<0.05, **=p<0.01, ***=p<0.001. Non-significant results are left blank. For significant results, the highest value is tabulated in bold type.

Species	Foredune	Dune	Sml Rhiz	Lge Rhiz	Mixed	Ceriops	H	p
Number of sites	3	3	3	3	3	3		
Total species richness for vegetation type	27	27	24	21	25	20		
Site species richness	4.8	5.8	5.6	4.8	6.9	4.8		
Site bird abundance	7.3	10.2	7.5	5.8	11.4	8.3		
Orange-footed Scrubfowl *Megapodius reinwardt* (GIO)	0.3	0.0	0.0	0.0	0.0	0.0	15.4	**
Whimbrel *Numenius phaeopus* (AQ)	0.0	0.0	0.2	0.0	0.0	0.3		
Rose-crowned Fruit-dove *Ptilinopus regina* (FR)	0.2	0.1	0.2	0.2	0.1	0.0		
Peaceful Dove *Geopelia striata* (GR)	0.2	0.1	0.0	0.0	0.0	0.2		
Bar-shouldered Dove *Geopelia humeralis* (GR)	0.2	0.5	0.0	0.0	0.0	0.2	24.4	***
Rainbow Lorikeet *Trichoglossus haematodus* (NE)	1.8	0.7	0.5	0.0	0.0	1.8		
Little Bronze-cuckoo *Chrysococcyx minutillus* (FI)	0.2	0.0	0.3	0.3	0.4	0.2	10.0	<0.1
Little Kingfisher *Alcedo pusilla* (AQ)	0.0	0.0	0.0	0.1	0.1	0.1		
Collared Kingfisher *Todiramphus chloris* (RA)	0.0	0.2	0.0	0.4	0.1	0.0	12.7	*
Rainbow Bee-eater *Merops ornatus* (AI)	0.7	0.2	0.1	0.0	0.5	0.6	10.0	<0.1
White-bellied Cuckoo-shrike *Coracina papuensis* (FI)	0.1	0.1	0.1	0.0	0.0	0.0		
Cicadabird *Coracina tenuirostris* (FI)	0.1	0.0	0.1	0.2	0.1	0.0		
Varied Triller *Lalage leucomela* (FI)	0.7	0.3	0.1	0.1	0.5	0.1	15.6	**
Mangrove Robin *Eopsaltria pulverulenta* (GIO)	0.0	0.0	0.0	0.3	0.1	0.0	11.4	*
Spectacled Monarch *Monarcha trivirgatus* (AI)	0.2	0.1	0.1	0.3	0.2	0.0		
Shining Flycatcher *Myiagra alecto* (AI)	0.1	0.0	0.1	0.5	0.7	0.5	12.6	*
Willie Wagtail *Rhipidura leucophrys* (GIO)	0.0	0.3	0.1	0.0	0.1	0.0		
Rufous Fantail *Rhipidura rufifrons* (AI)	0.1	0.0	0.0	0.0	0.1	0.1		
Spangled Drongo *Dicrurus bracteatus* (AI)	0.0	0.3	0.0	0.3	0.3	0.1		
Variegated Fairy-wren *Malurus lamberti* (GIO)	0.0	0.1	0.0	0.0	0.0	0.3		
Mangrove Gerygone *Gerygone levigaster* (FI)	0.0	0.3	0.6	0.3	0.1	0.3	12.3	*
Helmeted Friarbird *Philemon buceroides* (FIN)	1.3	0.2	0.8	0.1	1.0	0.9	13.9	*
Yellow-spotted Honeyeater *Meliphaga notata* (FIN)	0.4	0.3	0.4	0.4	0.8	0.3		
Graceful Honeyeater *Meliphaga gracilis* (NE)	0.3	0.1	0.9	0.3	0.6	0.4	10.3	<0.1
Varied Honeyeater *Lichenostomus versicolor* (FIN)	0.0	0.0	0.4	0.2	0.0	0.0	11.4	*
Brown Honeyeater *Lichmera indistincta* (NE)	1.1	0.3	0.4	0.8	2.3	2.5	16.7	**
Brown-backed Honeyeater *Ramsayornis modestus* (NE)	0.2	0.0	0.2	0.0	0.9	0.5		
Dusky Honeyeater *Myzomela obscura* (NE)	0.2	0.3	0.3	0.3	0.8	0.0		
Yellow-bellied Sunbird *Nectarinia jugularis* (NE)	0.6	1.2	1.0	0.3	0.8	0.3	17.6	**
Mistletoebird *Dicaeum hirundinaceum* (FR)	0.9	0.6	0.3	0.2	0.4	0.3	9.5	<0.1
Yellow Oriole *Oriolus flavocinctus* (FI)	0.1	0.0	0.4	0.4	0.3	0.3		
Black Butcherbird *Cracticus quoyi* (RA)	0.2	0.0	0.1	0.0	0.1	0.2		

Species recorded only once in the 18 sites and therefore not used in the species analyses: Striated Heron *Butorides striatus* (AQ), Beach Stone-curlew *Esacus neglectus* (AQ), *Spotted Turtle-dove *Streptopelia chinensis* (GR), Pied Imperial-pigeon *Ducula bicolour* (FR), Rufous Owl *Ninox rufa* (RA), Papuan Frogmouth *Podargus papuensis* (RA), White-rumped Swiftlet *Collocalia spodiopygius* (AI), Dollarbird *Eurystomus orientalis* (AI), Varied Triller *Lalage leucomela* (FI), Magpie-lark *Grallina cyanoleuca* (GIO), Lewin's Honeyeater *Meliphaga lewinii* (FIN), Yellow Honeyeater *Lichenostomus flavus* (FIN), White-throated Honeyeater *Melithreptus albogularis* (FIN), *Nutmeg Manikin *Lonchura punctulata* (GR), Figbird *Sphecotheres viridis* (FR), White-breasted Woodswallow *Artamus leucorynchus* (AI).

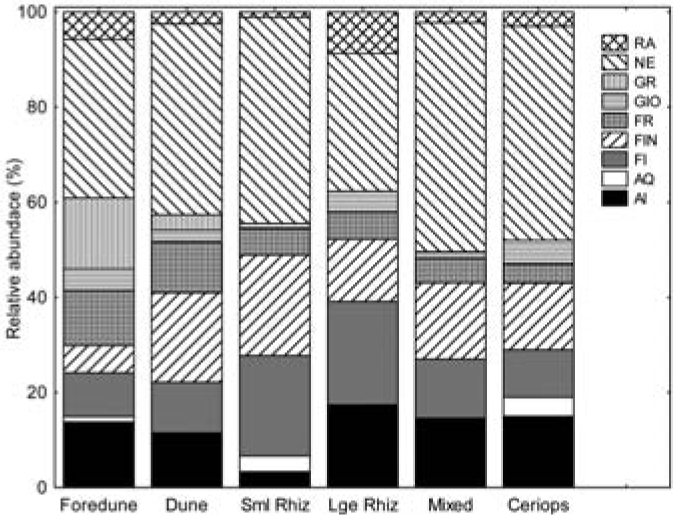

Figure 3. Relative abundance of foraging guilds in each vegetation type.

Gerygone), whilst conversely the Peaceful Dove and Bar-shouldered Dove, both considered mangrove-facultative, were recorded exclusively on the dunes. The species richness of mangrove-endemic bird species in Australia is thought to be related to both the extensive area of mangroves and, due to the scarcity of rainforest in north-western Australia, the opportunity for differentiation between rainforest and mangrove fauna in periods of aridity (Ford 1982; Noske 1996).

Many of the birds recorded in the assemblage are more commonly associated with different vegetation types; beaches and foredunes (Beach Stone-curlew, Whimbrel); closed forests (Orange-footed Scrubfowl, Lewin's Honeyeater, Graceful Honeyeater, Spectacled Monarch, Rose-crowned Fruit-dove); and open forests and woodlands (Variegated Fairy-wren, White-throated Honeyeater, Yellow Honeyeater) (Woinarski *et al.* 1988; Kemp and Kutt 2005; Kutt *et al.* 2005). Some of the species occur most abundantly in coastal *Melaleuca* woodlands and swamps adjacent to mangroves (Brown-backed Honeyeater, Yellow Oriole), and others are widespread in a range of habitats (Rainbow Lorikeet, Dollarbird, Figbird, Yellow-bellied Sunbird, Mistletoebird) (Woinarski *et al.* 1988; Kemp and Kutt 2005; Kutt *et al.* 2005). A few species were idiosyncratic in that they are species more normally found in disturbed or cleared habitats (Nutmeg Manikin, Spotted Turtle-dove, Willie Wagtail, Magpie-lark).

Similarly, Woinarski *et al.* (1988) examined bird distribution patterns in a complex vegetation mosaic on Howard's Peninsula, NT, and recorded 28 species utilising mangroves, with only four species (Mangrove Gerygone, Mangrove Fantail, Mangrove Golden-whistler and Great-billed Heron) restricted to this vegetation type. Four species considered mangrove specialists by Noske (1996) (Broad-billed Flycatcher, Red-headed Honeyeater, Black Butcherbird and Yellow White-eye) were recorded in adjacent closed forest, *Melaleuca* woodland and riparian environments (Woinarski *et al.* 1988). Naturally this suggests that the surrounding landscape mosaic as well as the habitat itself influence compositional patterns at any one site. The shifting intra and inter-annual seasonal patterns of birds in the intact tropical savanna landscapes is a well-accepted determinant of species pattern in northern Australia (Woinarski *et al.* 2000; Franklin *et al.* 2005).

Habitat structure and floristic composition is a common determinant of bird assemblages (Recher 1969). The highest species abundance and richness were recorded in the dunes and the mixed mangrove vegetation types reflecting a relationship with higher plant and structural diversity. The dune systems, which have a gramineous understorey, and a more structurally diverse mix of fruiting and flowering plants than the mangroves, hosted more granivores, frugivores and ground insectivores/omnivores. The foredunes are weedy esplanades with low vegetation cover and were the only vegetation type where introduced species (e.g. Nutmeg Manikin, Spotted Turtle-dove) were recorded. A similar pattern has been reported in other coastal dune systems in north Queensland (Kemp and Kutt 2005).

In the Northern Territory, there was clear association between some bird species and the *Rhizophora* and *Bruguiera* mangrove zones (Noske 1996). In this study, species observed with significantly higher abundance in mangrove vegetation types (e.g. Mangrove Robin, Varied Honeyeater and Yellow Oriole), were also associated with *Rhizophora* and mixed *Rhizophora*/*Ceriops* communities. *Rhizophora* is structurally a more complex mangrove (taller, large aerial roots), which undergoes greater cycles of tidal inundation and may provide more suitable habitat to mangrove-specialised birds. Most mangrove associated birds recorded in this study were ubiquitous in all mangrove zones. This lack of assemblage pattern may be a function of smaller area and the inter-dispersed vegetation types in the study area, which contrasts to the larger, clearly delineated mangrove zones in the community studied in Darwin (Noske 1996).

Mangrove systems are notable for a productivity that supports a moderately high-density and diversity of birds for a very low floristic diversity (Noske 1996). Despite an interacting seasonal effect for bird species richness, which is likely a result of flowering or fruiting in that vegetation type (e.g. high species richness in Dune, *Ceriops* and mixed mangrove in April), the large number of birds that were ubiquitous across many vegetation types suggests it is likely that the matrix of vegetation at the CIA sustains a largely resident population of birds of stable composition. The extant pattern of bird distribution in the CIA must be in part due to the mosaic of vegetation present which provides an annual range of resources suitable for a mix of nectarivorous, insectivorous, granivorous and frugivorous birds. The presence of the dunes has permitted a large diversity of non-mangrove and partially mangrove-dependent birds to co-exist in a small area. Mangroves seemingly not only support specialised and locally restricted bird assemblages, but also form an integral seasonal resource for birds utilising adjacent coastal woodland, grassland and wetland complexes (e.g. honeyeaters). Despite the local peculiarities, driven by regional landscape context, there is still good correspondence of bird assemblage patterns of mangroves between the Northern Territory and Queensland.

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